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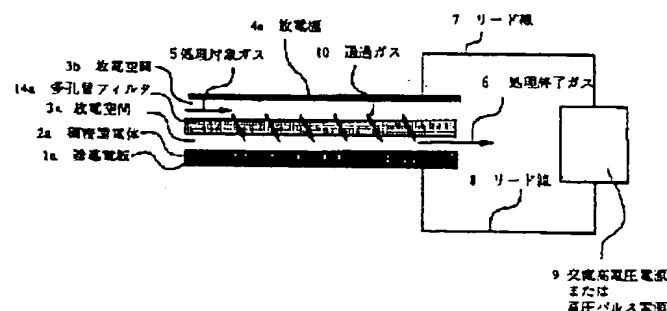
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TITLE : CORONA DISCHARGE ELEMENT AND
GAS TREATMENT DEVICE USING IT



ABSTRACT : PROBLEM TO BE SOLVED: To simultaneously remove particle-like contaminant and gaseous contaminant in exhaust gas by sandwiching at least one out of a porous filter composed of dielectric body and a dense dielectric body between a pair of electrodes.

SOLUTION: An induction electrode 1a which is put into close contact with a dense dielectric body 2a made of ceramic such as alumina or glass such as quartz and is made of a plate, a net, or an deposited film of a conductive or semiconductive material and a discharge electrode 4a which is parallel to the induction electrode 1a are disposed. A plate-like porous filter 14a composed of dielectric material such as ceramic is disposed between the dielectric body 2a and the discharge electrode 4a to form discharge spaces 3a, 3b. Both electrodes 1a and 4a are held such that they are insulated from each other and an alternating current high voltage power source or a high voltage pulse power source 9 is connected between the electrodes 1a and 4a via lead wires 7, 8. Particle-like contaminant in the exhaust gas to be treated is filtered and removed by the porous filter 14a and gaseous contaminant is dissolved by discharge plasma into radical safe gas and is removed.

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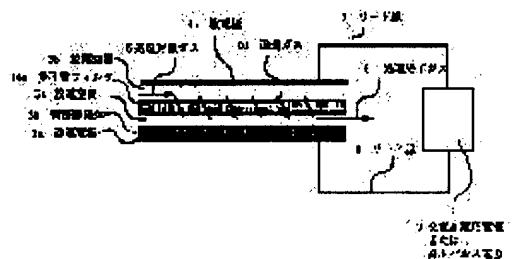
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(54) CORONA DISCHARGE ELEMENT AND GAS TREATMENT DEVICE USING IT

(57)Abstract:

PROBLEM TO BE SOLVED: To simultaneously remove particle-like contaminant and gaseous contaminant in exhaust gas by sandwiching at least one out of a porous filter composed of dielectric body and a dense dielectric body between a pair of electrodes.

SOLUTION: An induction electrode 1a which is put into close contact with a dense dielectric body 2a made of ceramic such as alumina or glass such as quartz and is made of a plate, a net, or an deposited film of a conductive or semiconductive material and a discharge electrode 4a which is parallel to the induction electrode 1a are disposed. A plate-like porous filter 14a composed of dielectric material such as ceramic is disposed between the dielectric body 2a and the discharge electrode 4a to form discharge spaces 3a, 3b. Both electrodes 1a and 4a are held such that they are insulated from each other and an alternating current high voltage power source or a high voltage pulse power source 9 is connected between the electrodes 1a and 4a via lead wires 7, 8. Particle-like contaminant in the exhaust gas to be treated is filtered and removed by the porous filter 14a and gaseous contaminant is dissolved by discharge plasma into radical safe gas and is removed.



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CLAIMS

[Claim(s)]

[Claim 1] The corona discharge component characterized by putting every at least one porosity filter and dense dielectric which were constituted from a dielectric by inter-electrode [of this couple] in the corona discharge component which alternating current high tension or a pulse height electrical potential difference is impressed [component] to inter-electrode [of the couple insulated by **], and generates corona discharge, respectively.
[Claim 2] the porosity filter which consisted of dielectrics which have pore by which an alternating current high-tension power source or a pulse height electrical-potential-difference power source is connected to inter-electrode [of the couple insulated by **], and processed gas is filtered by inter-electrode [of this couple] by passing, and ** -- the gas treatment equipment using the corona discharge component characterized by placing a dense dielectric between at least one at a time, respectively.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention removes and disassembles the particulate matter and the gaseous pollutant which are contained in exhaust gas, such as a diesel power plant and various boilers, or relates to the corona discharge component for purifying the gas containing various organic solvents, a chlorinated organic compound, an offensive odor, etc., and the gas treatment equipment using it.

[0002]

[Description of the Prior Art] As shown in drawing 9, the conventional corona discharge component Two electrode insulated 1a, Generate discharge of the format called silent discharge by putting dense dielectric 2a among 4a, and impressing alternating current high tension or a pulse voltage 9 between these two electrodes, or Discharge of the format called creeping discharge was generated by preparing electrode 1a in one side face of dense dielectric 2a, preparing discharge electrode 4b in other side faces, and impressing alternating current high tension or a pulse voltage between these two electrodes, as shown in drawing 10.

[0003] moreover, a swage block in order to remove the particulate matter contained in the exhaust gas of a diesel power plant, as shown in drawing 11 -- using the ceramic filter 11 of a **, as passage gas 10 showed, when close [a gas inlet 12 to] passed the porosity ceramic filter 11, it carried out separation clearance of the particulate matter, and processing-object gas 5 had discharged as processing termination gas 6 from the gas outlet 13.

[0004] Particulate matter was unremovable, although the plasma was able to be generated and the chemical reaction of the radical generated in the plasma and the gaseous pollutant in exhaust gas was able to be generated with such a conventional silent discharge corona discharge component and a conventional creeping-discharge corona discharge component.

[0005] Moreover, as for the plasma generated with a silent discharge corona discharge component or a creeping-discharge corona discharge component, as a result of being formed on the front face of the very thin channel and the dense dielectric which are generated in non-denses in the opening of discharge space 3a, the probability of collision of a radical and the molecule of the gaseous pollutant in exhaust gas is small, and processing had taken time amount.

[0006] On the other hand, although the particulate matter which uses the carbon in diesel exhaust gas as a principal component was removable in the ceramic filter, to the gaseous pollutant, it was ineffective.

[0007] Furthermore, since the particulate matter removed out of exhaust gas with the ceramic filter was accumulated on a filter and produced clogging, it needed the activity which it heats periodically, and carbon is burned and is removed.

[0008] There was a case where temperature carried out abnormality lifting locally and a ceramic filter was damaged, at that time.

[0009]

[Problem(s) to be Solved by the Invention] The object of this invention is enabling it to emit the particulate matter and the gaseous pollutant in exhaust gas outside as pure gas by removing simultaneously.

[0010] Other objects are shortening time amount (processing time) required in order to raise the probability of collision of the radical and gaseous pollutant molecule which are generated with the plasma, to disassemble the gaseous pollutant molecule in the oxidation and a reduction operation and to change into a safe molecule.

[0011] Moreover, other objects are the plasma's removing as a carbon dioxide at low temperature, and preventing breakage by partial heating of said ceramic filter etc., when disassembling the particulate matter which uses the carbon in diesel exhaust gas as a principal component.

[0012] The object of further others is making the particulate matter which uses the carbon in diesel exhaust gas as a principal component act as a reducing agent of the nitrogen oxides in exhaust gas, changing nitrogen oxides into

nitrogen and processing them.

[0013]

[Means for Solving the Problem] To inter-electrode [of the couple insulated by ** produced with the metal the semi-conductor, etc.], the corona discharge component of this invention, and the processor using it Ceramics produced with dielectrics, such as a ceramic, such as a porosity filter and an alumina, Put every at least one dense dielectric produced with glass, such as quartz glass, respectively, and a corona discharge component is constituted. The corona discharge which impresses alternating current high tension or a pulse height electrical potential difference between these two electrodes, and has at least one discharge gestalt of creeping discharge, silent discharge, and void discharge is generated, and nonequilibrium plasma is generated.

[0014] At this time, particulate matter is deposited on a porosity filter in the process in which this porosity filter is passed for processing-object gas, such as exhaust gas, and it dissociates from exhaust gas.

[0015] On a porosity filter front face, creeping discharge within the pore of the shape of an internal minute opening simultaneously void discharge In order that the radical and gaseous pollutant by which at least one of the discharge [those] of each has occurred, and silent discharge is generated with the discharge plasma in the both sides or one side of a porosity filter may collide within the front face of a porosity filter, and internal pore As compared with the case where it collides only in the gas in the conventional discharge space, a probability of collision becomes large, oxidation / reduction reaction of a gaseous pollutant is promoted, and the processing time can be reduced.

[0016] Although especially the particulate matter that uses the carbon in exhaust gas as a principal component in the exhaust gas discharged from a diesel power plant is deposited on the filter in case it is filtered with a porosity filter, it oxidizes to a carbon dioxide in an operation of the oxidizing quality radical in the discharge plasma which exists there, turns into a gaseous substance, and is removed from on said filter.

[0017] Since the oxidation reaction to the carbon dioxide of the particulate matter which uses carbon as a principal component advances at low temperature at this time, problems, such as partial heating which leads to breakage on a ceramic filter, are not generated.

[0018] Moreover, since the exhaust gas discharged from a diesel power plant has the high oxygen density, it is difficult for an oxide with the still higher order nitrogen oxides in exhaust gas, for example, a nitrogen monoxide, to be [only oxidizing to a nitrogen dioxide, and], and to remove the nitrogen oxides in exhaust gas only with the discharge generation plasma, but if an operation of the discharge generation plasma is especially received on the surface of a ceramic filter by coexistence of a carbon-like particle, since it is returned even to nitrogen, nitrogen oxides will become possible [removing the nitrogen oxides in exhaust gas].

[0019]

[Embodiment of the Invention] The porosity filter produced with dielectrics, such as an alumina ceramic, to inter-electrode [of the couple insulated by ** produced with the metal, the semi-conductor, etc.], The dense dielectric produced with glass, such as ceramics, such as an alumina, and quartz glass The corona discharge component which it put at least one [at a time] is constituted, the corona discharge which has at least one discharge gestalt of creeping discharge, silent discharge, and void discharge by impressing alternating current high tension or a pulse height electrical potential difference between two electrodes is generated, and nonequilibrium plasma is generated.

[0020] When passing the porosity filter of the above-mentioned corona discharge component and purifying processing-object exhaust gas, the gas passageway for passing that is prepared in the interior of this porosity filter.

[0021] In case the particulate matter in processing-object exhaust gas is filtered with a porosity filter, it is removed, the radical generated with the discharge plasma decomposes into safe gas, and a gaseous pollutant is removed.

[0022] In case especially the particulate matter that uses carbon as a principal component when processing-object exhaust gas of a diesel power plant is filtered with a porosity filter, low temperature oxidation of it is carried out in an operation of the discharge plasma, and since it is changed and emitted to a carbon dioxide, the condition that there is always no blinding is held, and also a porosity filter returns the nitrogen oxides of the gaseous pollutant in exhaust gas under an operation of the discharge plasma, and can emit them as safe nitrogen gas.

[0023]

[Example] When the drawing of attachment of the example of the corona discharge component of this invention explains, as it is shown in drawing 1 It sticks to dense dielectric 2a produced with glass, such as ceramics, such as an alumina, and a quartz. By arranging discharge electrode 4a in parallel with electrode 1a produced by the plate of a conductor or a semi-conductor, the network, the vacuum evaporationo film, etc., and this, dielectric 2a and tabular porosity filter 14a which consisted of dielectrics, such as a ceramic, between discharge electrode 4a are placed, and discharge space 3a and 3b is formed.

[0024] And two electrodes 1a and 4a insulate and hold to **, and connect an alternating current high voltage power

supply or the high voltage pulse power source 9 through lead wire 7 and 8 between these two-electrodes 1a and 4a. [0025] If alternating current high tension or a high voltage pulse voltage is impressed to this inter-electrode ones, as shown in drawing 2 , 3d of silent discharge will be 14s of front faces of porosity filter 14a in discharge space 3a and 3b again, and void discharge 14vd will occur [creeping-discharge 14sd and 2sd(s)] in pore 14v inside porosity filter 14a further at 2s of front faces which touched the list at discharge space 3of dense dielectric 2a a.

[0026] the radical which generates the plasma by 3d of such silent discharge, creeping-discharge 14sd, 2sd, and void discharge 14vd, excites the gas molecule which exists in pore 14v inside discharge space 3a and 3b or porosity filter 14a, and is rich in reactivity -- for example, although not illustrated, NO*, O2*, OH, etc. generate N*, N2*, CO*, etc. and ozone to a large quantity as a reducibility radical as an oxidizing quality radical.

[0027] Moreover, are equipment as the example of the gas treatment equipment using an above-mentioned corona discharge component is also shown in drawing 1 , and it sets to drawing 2 which shows the operation situation of the equipment. Exhaust gas, such as a diesel power plant and various boilers, and an organic solvent, a chlorinated organic compound, If it introduces so that discharge space 3b of a side besides porosity filter 14a may be passed using the porosity filter 14 as passage gas 10 for processing-object gas 5, such as air containing an offensive odor etc., into discharge space 3a by the side of one of porosity filter 14a It collides with the radical and ozone molecule which are generated with the plasma, and oxidation / reduction reaction is carried out, and it is defanged and is emitted to the exterior of gas treatment equipment as processing termination gas 6 at the same time the gaseous pollutant in processing-object gas 5 receives bombardment of the electron in the discharge generation plasma directly in that case.

[0028] Simultaneously, since porosity filter 14a deposits the particulate matter contained in it on 14s of the front face in case it **** processing-object gas 5, the above-mentioned gaseous pollutant and the particulate matter of processing-object gas 5 are simultaneously removable.

[0029] Although particulate matter is using carbon as the principal component and carbon carries out filtration deposition on porosity filter 14a especially when processing-object gas 5 is diesel-power-plant exhaust gas, low temperature oxidation is carried out and it is defanged as a carbon dioxide, and it becomes gas and is emitted by operation of the discharge generation plasma.

[0030] Moreover, although a lot of nitrogen oxides which are mainly concerned with a nitrogen monoxide NO contain as a gaseous pollutant as shown in drawing 2 when processing-object gas 5 is diesel-power-plant exhaust gas As the carbon C by which filtration deposition was carried out on 14s of front faces of porosity filter 14a shows the reaction situation in the inside of the discharge plasma in the ellipse of this drawing, under the discharge generation plasma, it acts as a reducing agent. The reaction for which low temperature oxidation of the carbon C is carried out, and it serves as a carbon dioxide CO 2 is accompanied, and nitrogen oxides serve as nitrogen N2 by the reduction reaction, are defanged, serve as processing termination gas 6, and are discharged outside.

[0031] The corona discharge component of this invention and the gas-treatment-equipment example using it are not limited to what is shown in drawing 1 , and within the limits of this invention, it can change selectively, or they can be added and carried out. For example, instead of carrying out like the example of drawing 1 , insulator arrangement of the discharge electrode 4a which stuck to dense dielectric 2b like drawing 3 , and was produced by the plate of a conductor or a semi-conductor, the network, the vacuum evaporationo film, etc. may be carried out to parallel at electrode 1a.

[0032] Moreover, insulator arrangement of the corona discharge pole 4b produced by the plate of a conductor or a semi-conductor, the network, the vacuum evaporationo film, etc. so that gas, such as the shape of the shape of a slit, reticulated, and punching, could be directly passed on porosity filter 14a like drawing 4 may be carried out to parallel at electrode 1a.

[0033] Still like the example of drawing 1 , instead of forming a corona discharge component by electrode 1a, tabular dense dielectric 2a, discharge space 5, and ceramic filter 14made from tabular dielectric a, as shown not only in parallel-pole structure but in drawing 5 , you may form in the said alignment by cylindrical electrode 4c, discharge space 3a and 3b, ceramic filter 14made from cylindrical dielectric b, cylindrical dense dielectric 2c, and electrode 1b.

[0034] Or 2d of cylindrical dielectrics dense to the inner surface of cylindrical dielectric cylindrical electrode 4c in the example of said drawing 5 can also be arranged like the example of drawing 6 .

[0035] moreover -- or instead of preparing cylindrical electrode 4c in the example of said drawing 5 , as shown in drawing 7 , the periphery of ceramic filter 14made from cylindrical dielectric b can be contacted, and the shape of a ring and 4d of spiral corona discharge poles can also be arranged.

[0036] furthermore -- or as shown in drawing 8 , instead of the shape of a ring in the example of said drawing 7 , and 4d of spiral corona discharge poles, it is also possible to prepare wire gauze-like corona discharge pole 4e.

[0037] It is [part / as the drawing sign shown in drawing 1 in a drawing sign of the example shown in above-mentioned drawing 3 thru/or drawing 8 , and 2 / same] the same also about the name and function of the part.

[0038]

[Effect of the Invention] In case processing-object gas passes this porosity filter by having put every at least one porosity filter and dense dielectric which were constituted from a dielectric by inter-electrode [of the couple insulated by **], respectively It becomes possible to raise substantially an operation (electronic bombardment and collision with radical ozone) of the discharge generation plasma generated in the front face and internal pore of this porosity filter only as compared with the case of only passing discharge space.

[0039] And the front face of a porosity filter and the wall surface of internal pore serve as a field of the reaction of radical ozone and a gas harmful matter molecule, and oxidation / reduction reaction is promoted.

[0040] It becomes possible to shorten gassing time amount substantially only as compared with the case of only passing discharge space these results.

[0041] Moreover, when processing-object gas contains particle-like harmful matter, gas harmful matter and particle-like harmful matter can be removed simultaneously.

[0042] When especially processing-object gas is diesel-power-plant exhaust gas, the carbon filtered and accumulated receives an operation of the discharge generation plasma in a porosity filter, low temperature oxidation is carried out to it, nitrogen oxides are returned simultaneously, and it is changed into a carbon dioxide and nitrogen, respectively, and is emitted as harmless processing termination gas.

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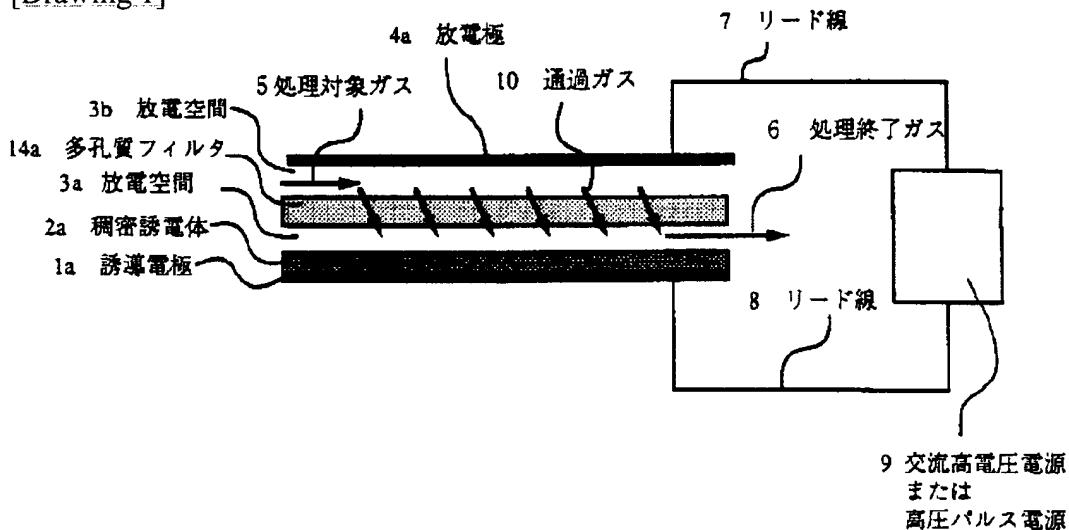
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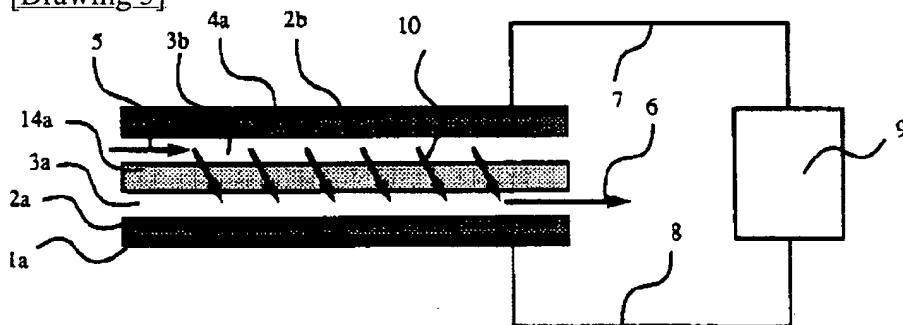
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DRAWINGS

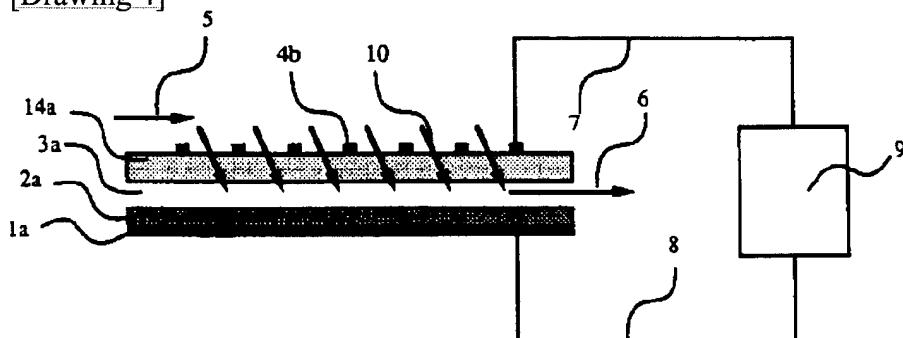
[Drawing 1]



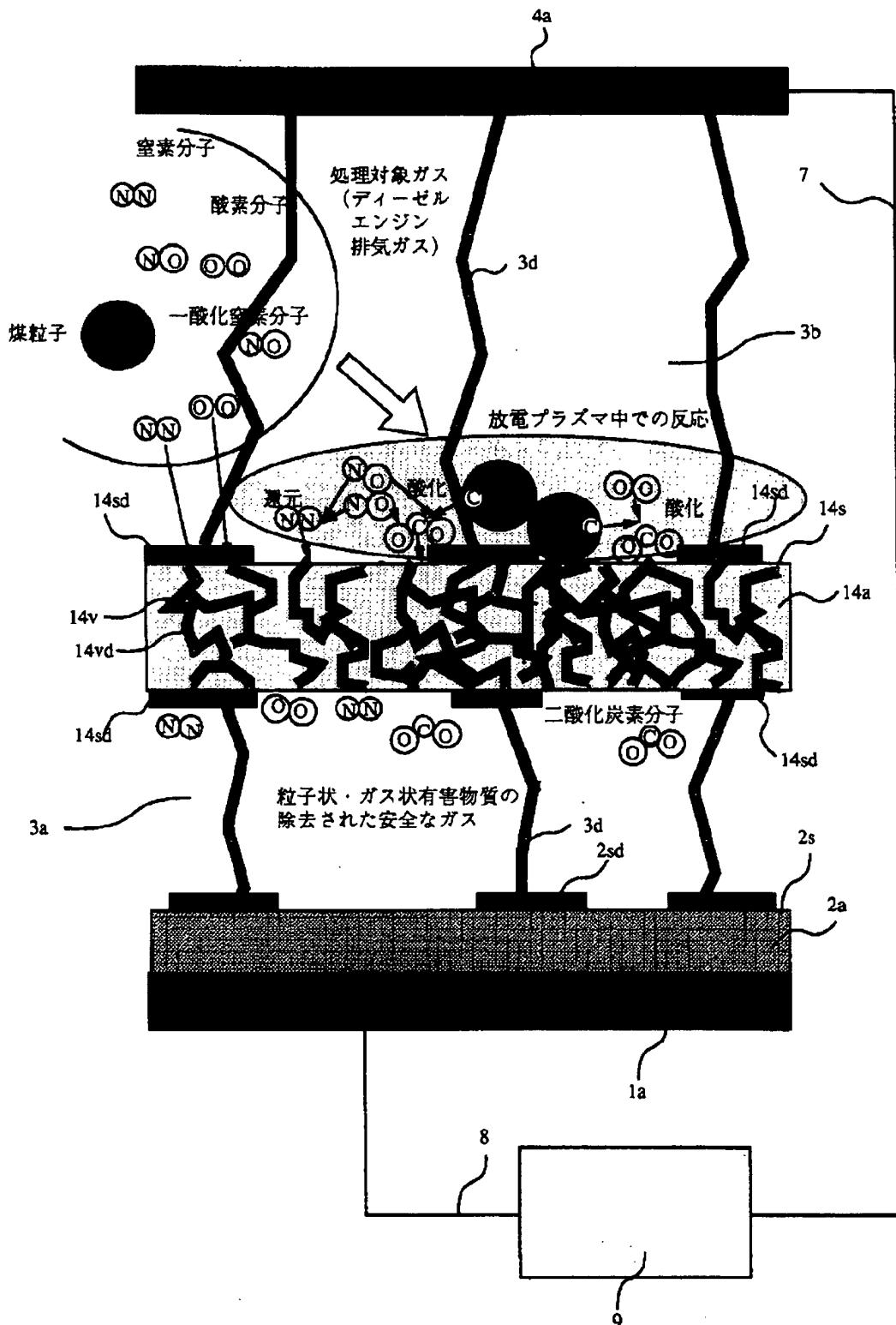
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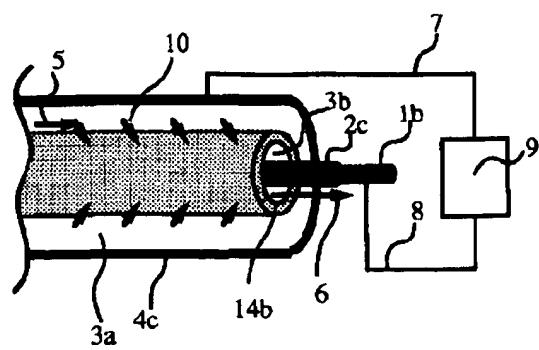
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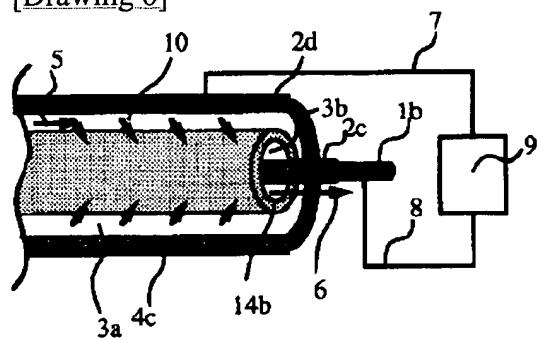
[Drawing 2]



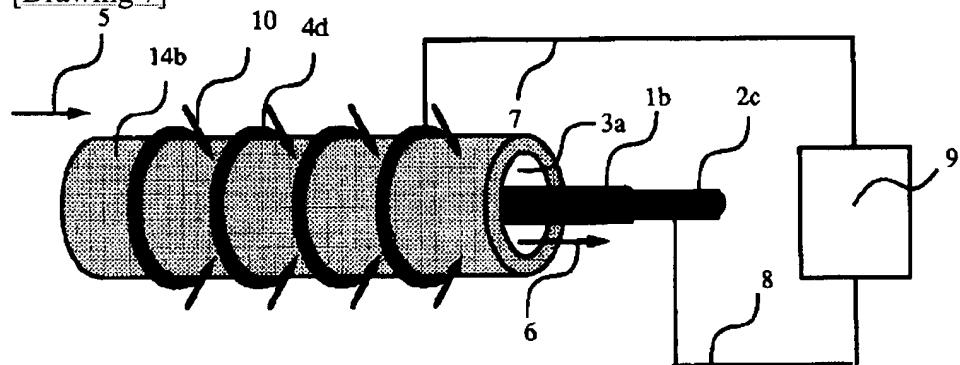
[Drawing 5]



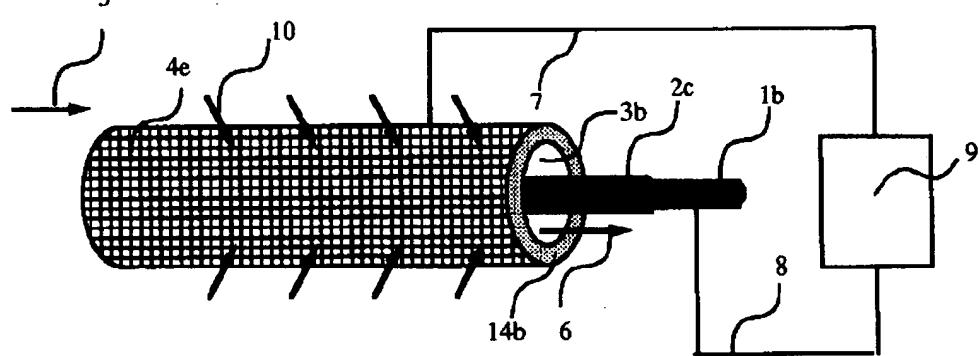
[Drawing 6]



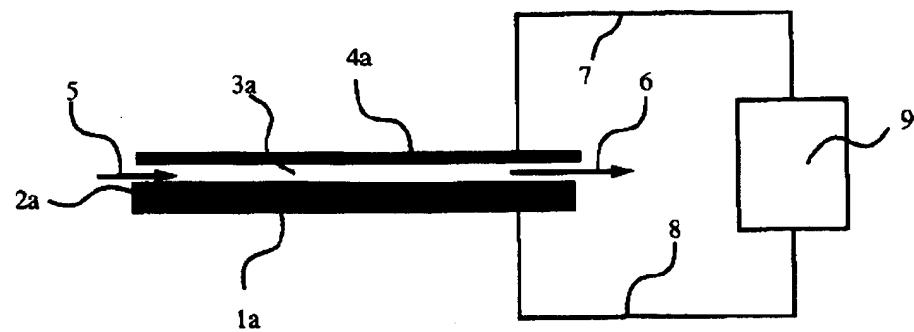
[Drawing 7]



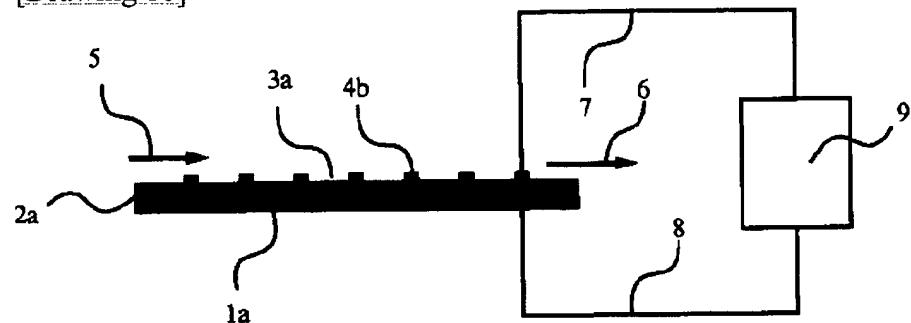
[Drawing 8]



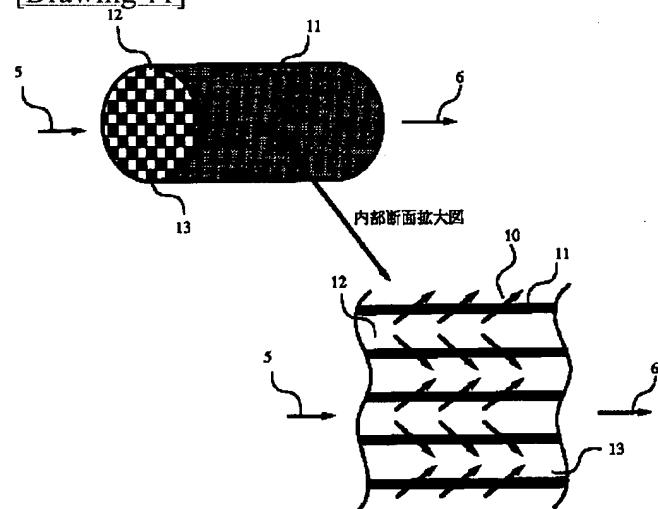
[Drawing 9]



[Drawing 10]



[Drawing 11]



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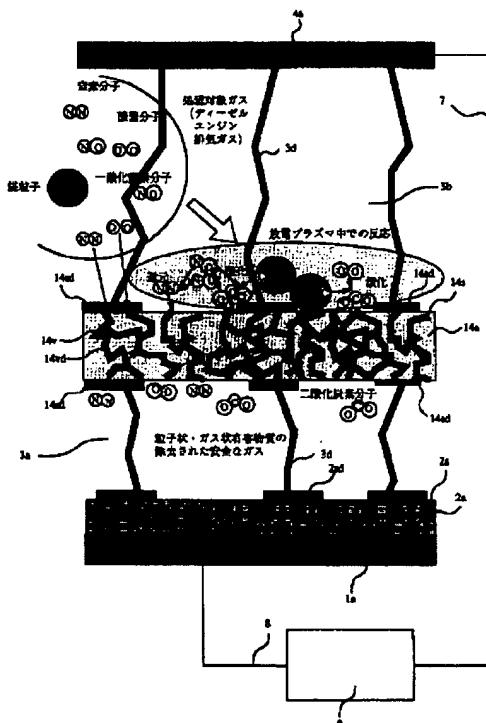
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(54)【発明の名称】 コロナ放電素子およびそれを用いたガス処理装置

(57)【要約】

【課題】 排ガス中の粒子状汚染物質とガス状汚染物質を同時に除去する。

【解決手段】 一対の電極間に誘電体で作成された多孔質フィルタ層と、稠密な誘電体で作成された誘電体層を介在し、両電極間に交流高圧電源を接続し、多孔質フィルタの表面とその内部の細孔の壁面に発生するラジカルやオゾンで、そこを通過するガス状及び粒子状有害物質を酸化及び還元して安全なガスにする。



【特許請求の範囲】

【請求項1】互に絶縁された一対の電極間に交流高電圧またはパルス高電圧を印加してコロナ放電を発生させるコロナ放電素子において、該一対の電極間に誘電体で構成された多孔質フィルタおよび稠密な誘電体を夫々少なくとも1つずつ挟み込んだことを特徴とするコロナ放電素子。

【請求項2】互に絶縁された一対の電極間に交流高電圧電源またはパルス高電圧電源を接続し、該一対の電極間に被処理ガスが通過して濾過されるような細孔を有する誘電体で構成された多孔質フィルタおよび稠密な誘電体を夫々少なくとも1つずつ介在することを特徴とするコロナ放電素子を用いたガス処理装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】この発明はディーゼルエンジン、各種ボイラーなどの排気ガス中に含まれる粒子状汚染物質ならびにガス状汚染物質を除去・分解したり、各種有機溶剤や有機塩素剤、悪臭などを含有するガスを浄化するためのコロナ放電素子ならびにそれを用いたガス処理装置に関するものである。

【0002】

【従来の技術】従来のコロナ放電素子は図9に示すように2つの絶縁された電極1a、4a間に稠密な誘電体2aを挟み込み、該両電極間に交流高電圧またはパルス電圧9を印加することにより無声放電と呼ばれる形式の放電を発生させたり、図10に示すように稠密な誘電体2aの一側面に誘導電極1aを、他側面に放電電極4bを設け該両電極間に交流高電圧またはパルス電圧を印加することにより沿面放電と呼ばれる形式の放電を発生させていた。

【0003】また、ディーゼルエンジンの排気ガス中に含まれる粒子状汚染物質を除去するために図11に示すような蜂の巣状のセラミックフィルタ11を用い、処理対象ガス5がガス入口12から入って多孔質セラミックフィルタ11を通過ガス10で示すように通過する際に粒子状汚染物質を分離除去し、ガス出口13から処理終了ガス6として排出していた。

【0004】このような従来の無声放電コロナ放電素子や沿面放電コロナ放電素子ではプラズマを発生させ、プラズマ中に生成されるラジカルと排ガス中のガス状汚染物質との化学反応を発生させることはできたが、粒子状汚染物質は除去することはできなかった。

【0005】また、無声放電コロナ放電素子や沿面放電コロナ放電素子で発生するプラズマは放電空間3aの空隙で疎らに発生する極細いチャネルや稠密な誘電体の表面で形成される結果、ラジカルと排ガス中のガス状汚染物質の分子との衝突確率が小さく処理に時間がかかっていた。

【0006】一方、セラミックフィルタではディーゼル

排ガス中のカーボンを主成分とする粒子状汚染物質は除去することはできたが、ガス状汚染物質に対しては効果がなかった。

【0007】さらに、セラミックフィルタで排ガス中より除去した粒子状汚染物質はフィルタ上に蓄積され目詰りを生じるため、定期的に加熱してカーボンを燃焼させて取り除く作業が必要であった。

【0008】その際、局所的に温度が異常上昇してセラミックフィルタが破損する場合があった。

【0009】

【発明が解決しようとする課題】この発明の目的は排ガス中の粒子状汚染物質とガス状汚染物質を同時に除去することで清浄なガスとして外部に放出できるようにすることである。

【0010】他の目的はプラズマで生成されるラジカルとガス状汚染物質分子との衝突確率を高めて、そのガス状汚染物質分子を酸化作用と還元作用で分解して安全な分子に変換するために要する時間（処理時間）を短くすることである。

【0011】また他の目的は、ディーゼル排ガス中のカーボンを主成分とする粒子状汚染物質を分解する場合、プラズマにより低温で二酸化炭素として除去し、前記セラミックフィルタの局所加熱による破損などを防止することである。

【0012】さらに他の目的は、ディーゼル排ガス中のカーボンを主成分とする粒子状汚染物質を排ガス中の窒素酸化物の還元剤として作用させ、窒素酸化物を窒素に変換して処理することである。

【0013】

【課題を解決するための手段】この発明のコロナ放電素子およびそれを用いた処理装置は金属や半導体などで作製された互に絶縁された一対の電極間に、セラミックなどの誘電体で作製した多孔質フィルタとアルミナなどのセラミックや、石英ガラスなどのガラスで作製した稠密な誘電体を夫々少なくとも1つずつ挟み込んでコロナ放電素子を構成し、該両電極間に交流高電圧もしくはパルス高電圧を印加して沿面放電、無声放電、ボイド放電の少なくとも1つの放電形態を有するコロナ放電を発生させ、非平衡プラズマを発生させるものである。

【0014】この時、排ガスなどの処理対象ガスを該多孔質フィルタを通過させる過程で粒子状汚染物質を多孔質フィルタ上に堆積して排ガスから分離するものである。

【0015】同時に、多孔質フィルタ表面上では沿面放電が、内部の微小空隙状の細孔内ではボイド放電が、多孔質フィルタの両側もしくは片側では無声放電が、それらの各放電の少なくとも1つが発生しており、放電プラズマで生成されるラジカルとガス状汚染物質が多孔質フィルタの表面及び内部の細孔内で衝突するために、従来の放電空間におけるガス中のみで衝突する場合と比較し

て衝突確率が大きくなり、ガス状汚染物質の酸化・還元反応が促進され処理時間が低減できる。

【0016】特に、ディーゼルエンジンから排出される排ガスでは、排ガス中のカーボンを主成分とする粒子状汚染物質は多孔質フィルタで濾過される際、そのフィルタ上に堆積するが、そこに存在する放電プラズマ中の酸化性ラジカルの作用で二酸化炭素に酸化され、ガス状物質となって前記フィルタ上から除去される。

【0017】この時、カーボンを主成分とする粒子状汚染物質の二酸化炭素への酸化反応は低温で進行するため、セラミックフィルタの損傷につながる局所加熱などの問題は発生しない。

【0018】また、ディーゼルエンジンから排出される排ガスは酸素濃度が高いため、放電生成プラズマだけでは排ガス中の窒素酸化物は一層高次の酸化物、例えば一酸化窒素は二酸化窒素に酸化されるのみで、排ガス中の窒素酸化物を除去することが難しいが、カーボン状粒子の共存で、特に、セラミックフィルタの表面で放電生成プラズマの作用を受けると窒素酸化物は窒素にまで還元されるため、排ガス中の窒素酸化物を除去することが可能となる。

【0019】

【発明の実施の形態】金属や半導体などで作製された互に絶縁された一対の電極間にアルミナセラミックなどの誘電体で作製した多孔質フィルタと、アルミナなどのセラミックや石英ガラスなどのガラスで作製した稠密な誘電体を、少なくとも1つずつ挟み込んだコロナ放電素子を構成し、両電極間に交流高電圧もしくはパルス高電圧を印加することで沿面放電、無声放電、ボイド放電の少なくとも1つの放電形態を有するコロナ放電を発生させ非平衡プラズマを発生させる。

【0020】処理対象排ガスを上記コロナ放電素子の多孔質フィルタを通過させて浄化する場合は、該多孔質フィルタの内部にそこを通過させるためのガス流路を設ける。

【0021】処理対象排ガス中の粒子状汚染物質は多孔質フィルタにより濾過される際、除去され、ガス状汚染物質は放電プラズマで生成されるラジカルにより安全なガスに分解して除去される。

【0022】特に、処理対象排ガスがディーゼルエンジンの排ガスの場合、カーボンを主成分とする粒子状汚染物質は多孔質フィルタで濾過される際、放電プラズマの作用で低温酸化して二酸化炭素に変換されて放出されるため、多孔質フィルタは常に目詰まりのない状態が保持されるうえに、排ガス中のガス状汚染物質の窒素酸化物を放電プラズマの作用の下で還元して安全な窒素ガスとして放出できる。

【0023】

【実施例】この発明のコロナ放電素子の実施例を添付の図面で説明すると図1に示すように、アルミナなどのセ

ラミックや石英などのガラスで作製した稠密な誘電体2aに密着して、導体または半導体の板、網、蒸着膜などで作製した誘導電極1aと、これに平行して放電極4aを配置して、誘電体2a、放電極4aの間にセラミックなどの誘電体で構成された板状の多孔質フィルタ14aを置いて放電空間3a、3bを形成する。

【0024】そして、両電極1a、4aは互に絶縁して保持し、該両電極1a、4a間にリード線7、8を介して交流高圧電源もしくは高圧パルス電源9を接続するものである。

【0025】該電極間に交流高電圧もしくは高圧パルス電圧を印加すると図2に示す如く放電空間3a、3bで無声放電3dが、また、多孔質フィルタ14aの表面14sで、並びに稠密な誘電体2aの放電空間3aに接した表面2sで沿面放電14sdおよび2sdがさらに、多孔質フィルタ14a内部の細孔14vではボイド放電14vdが発生する。

【0026】これらの無声放電3d、沿面放電14s d、2sd、ボイド放電14vdでプラズマを生成し、放電空間3a、3bもしくは多孔質フィルタ14a内部の細孔14vに存在するガス分子を励起し、反応性に富むラジカル例えば図示していないが、酸化性ラジカルとしてNO_x、O_{2*}、OHなど、還元性ラジカルとしてN_x、N_{2*}、CO_xなどやオゾンを大量に生成する。

【0027】また上述のコロナ放電素子を用いたガス処理装置の実施例も図1に示す通りの装置であって、その装置の作用状況を示す図2において、ディーゼルエンジン、各種ボイラーなどの排ガスや、有機溶剤、有機塩素剤、悪臭などを含む空気などの処理対象ガス5を多孔質フィルタ14aの一側の放電空間3a内に、その多孔質フィルタ14aを通過ガス10として多孔質フィルタ14aの他側の放電空間3bを通過するように導入すると、その際、処理対象ガス5中のガス状汚染物質は放電生成プラズマ中の電子の射突を直接受けると同時に、プラズマで生成されるラジカルやオゾン分子と衝突して酸化・還元反応し、無害化され処理終了ガス6としてガス処理装置の外部に放出される。

【0028】同時に多孔質フィルタ14aは処理対象ガス5を濾過する際、その中に含まれる粒子状汚染物質をその表面14s上に堆積するので、前述の処理対象ガス5のガス状汚染物質と粒子状汚染物質を同時に除去できる。

【0029】特に、処理対象ガス5がディーゼルエンジン排ガスの場合には粒子状汚染物質はカーボンを主成分としており、多孔質フィルタ14a上にカーボンが濾過堆積するが、放電生成プラズマの作用により、低温酸化され二酸化炭素として無害化されガスとなって放出される。

【0030】また、処理対象ガス5がディーゼルエンジン排ガスの場合には図2に示すように一酸化窒素NOを

主とする窒素酸化物がガス状汚染物質として多く含有されているが、多孔質フィルタ 1 a の表面 1 a 上に濾過堆積されたカーボン C が同図の梢円内の放電プラズマ中での反応状況に示す如く放電生成プラズマ下では還元剤として作用し、カーボン C が低温酸化されて二酸化炭素 CO_2 となる反応に付随して、窒素酸化物は還元反応により窒素 N_2 となって無害化され処理終了ガス 6 となって外部に排出される。

【0031】この発明のコロナ放電素子及びそれを用いたガス処理装置実施例は図 1 に示すものに限定されるものではなく、この発明の範囲内で部分的に変更したり、付加して実施することができる。例えば図 1 の実施例のようにする代りに、図 3 のように稠密な誘電体 2 b に密着して導体または半導体の板、網、蒸着膜などで作製した放電極 4 a を誘導電極 1 a に平行に絶縁配置してもよい。

【0032】また、図 4 のように多孔質フィルタ 1 a 上に直接、スリット状、網状、パンチング状などガスが通過できるように導体または半導体の板、網、蒸着膜などで作製したコロナ放電極 4 b を誘導電極 1 a に平行に絶縁配置してもよい。

【0033】さらに図 1 の実施例のように、誘導電極 1 a、板状稠密誘電体 2 a、放電空間 5、板状誘電体製セラミックフィルタ 1 a でコロナ放電素子を形成する代りに、平行電極構造のみならず、図 5 に示すように円筒状誘導電極 4 c、放電空間 3 a、3 b、円筒状稠密誘電体 2 c、誘導電極 1 b で同心的に形成してもよい。

【0034】或は、図 6 の実施例のように前記図 5 の実施例における、円筒状誘電体円筒状誘導電極 4 c の内面に稠密な円筒状誘電体 2 d を配置することもできる。

【0035】また或は図 7 に示すように、前記図 5 の実施例における円筒状誘導電極 4 c を設ける代りに、円筒状誘電体製セラミックフィルタ 1 b の外周に接触してリング状、若しくは螺旋状コロナ放電極 4 d を配置することもできる。

【0036】さらに或は図 8 に示すように前記図 7 の実施例におけるリング状若しくは螺旋状コロナ放電極 4 d の代りに、金網状コロナ放電極 4 e を設けることも可能である。

【0037】上記図 3 乃至図 8 に示した実施例の図面符号中図 1 及び 2 に示す図面符号と同一の部分については、その部分の名称及び機能についても同一である。

【0038】

【発明の効果】互に絶縁された一対の電極間に誘電体で構成された多孔質フィルタおよび稠密な誘電体を夫々少なくとも 1 つずつ挟み込んでいることによって処理対象ガスが該多孔質フィルタを通過する際に、単に放電空間を通過させるだけの場合に比較して、該多孔質フィルタの表面や内部細孔で発生する放電生成プラズマの作用

(電子の射突やラジカル・オゾンとの衝突) を大幅に向上させることが可能となる。

【0039】しかも、多孔質フィルタの表面、内部の細孔の壁面がラジカル・オゾンとガス状有害物質分子との反応の場となり酸化・還元反応が促進される。

【0040】これらの結果、単に放電空間を通過させるだけの場合に比較してガス処理時間を大幅に短縮することが可能となる。

【0041】また、処理対象ガスが粒子状有害物質を含有する場合には、ガス状有害物質と粒子状有害物質を同時に除去できる。

【0042】特に処理対象ガスがディーゼルエンジン排ガスの場合には多孔質フィルタに濾過・蓄積されたカーボンが放電生成プラズマの作用を受け低温酸化され、同時に窒素酸化物が還元され、それぞれ二酸化炭素、窒素に変換され無害な処理終了ガスとして放出される。

【図面の簡単な説明】

【図 1】この発明の実施例の断面図である。

【図 2】図 1 の実施例における作用状況を示す拡大断面図である。

【図 3】この発明の別の実施例の構造断面図である。

【図 4】この発明の他の実施例の構造断面図である。

【図 5】図 1 の放電素子を同心円筒状構造にした実施例である。

【図 6】図 2 の放電素子を同心円筒状構造にした実施例である。

【図 7】図 4 の放電素子を同心円筒状構造にした実施例である。

【図 8】図 7 の実施例を部分的に変更した実施例である。

【図 9】従来の放電素子の断面図である。

【図 10】従来の沿面放電コロナ放電素子の構造断面図である。

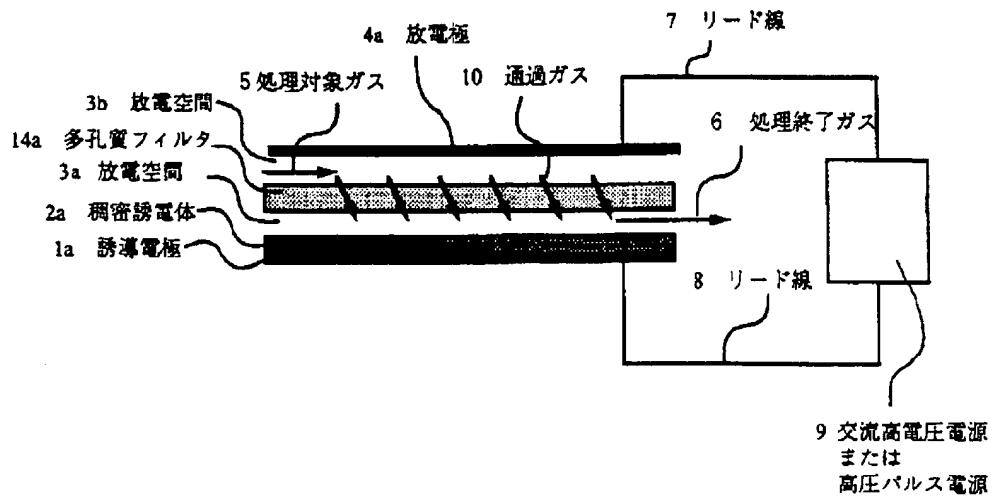
【図 11】従来のディーゼルエンジン用セラミックフィルタとその内部の部分的拡大断面図である。

【符号の説明】

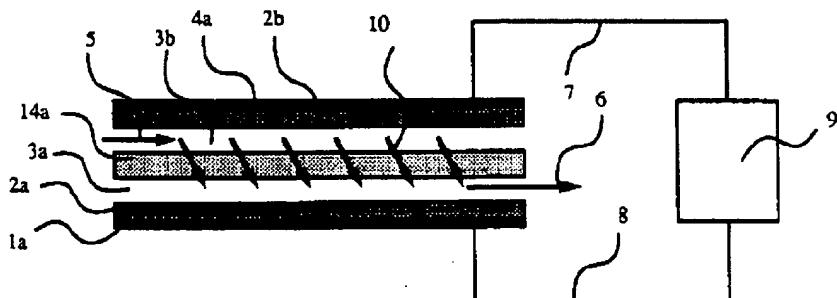
1 a、1 b	誘導電極
2 a、2 b	板状稠密誘電体
2 c、2 d	円筒状稠密誘電体
2 s	誘電体の放電空間に接した表面
2 s d	沿面放電
3 a、3 b	放電空間
3 d	無声放電
4 a	放電極
4 b	コロナ放電極
4 c	円筒状誘導電極
4 d	リング状または螺旋状コロナ放電極
4 e	金網状コロナ放電極
5	処理対象ガス
6	処理終了ガス

7、8	リード線	14 b	円筒状誘電体製セラミックフィルタ
9	交流高圧電源または高圧パルス電源	14 v	細孔
10	通過ガス	14 v d	ポイド放電
11	多孔質セラミック壁	14 s	多孔質フィルタの表面
12、13	ガス出入口孔	14 s d	沿面放電
14 a	多孔質フィルタ		

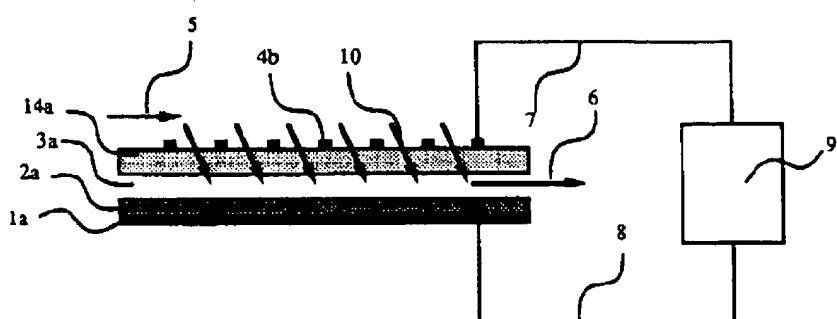
【図1】



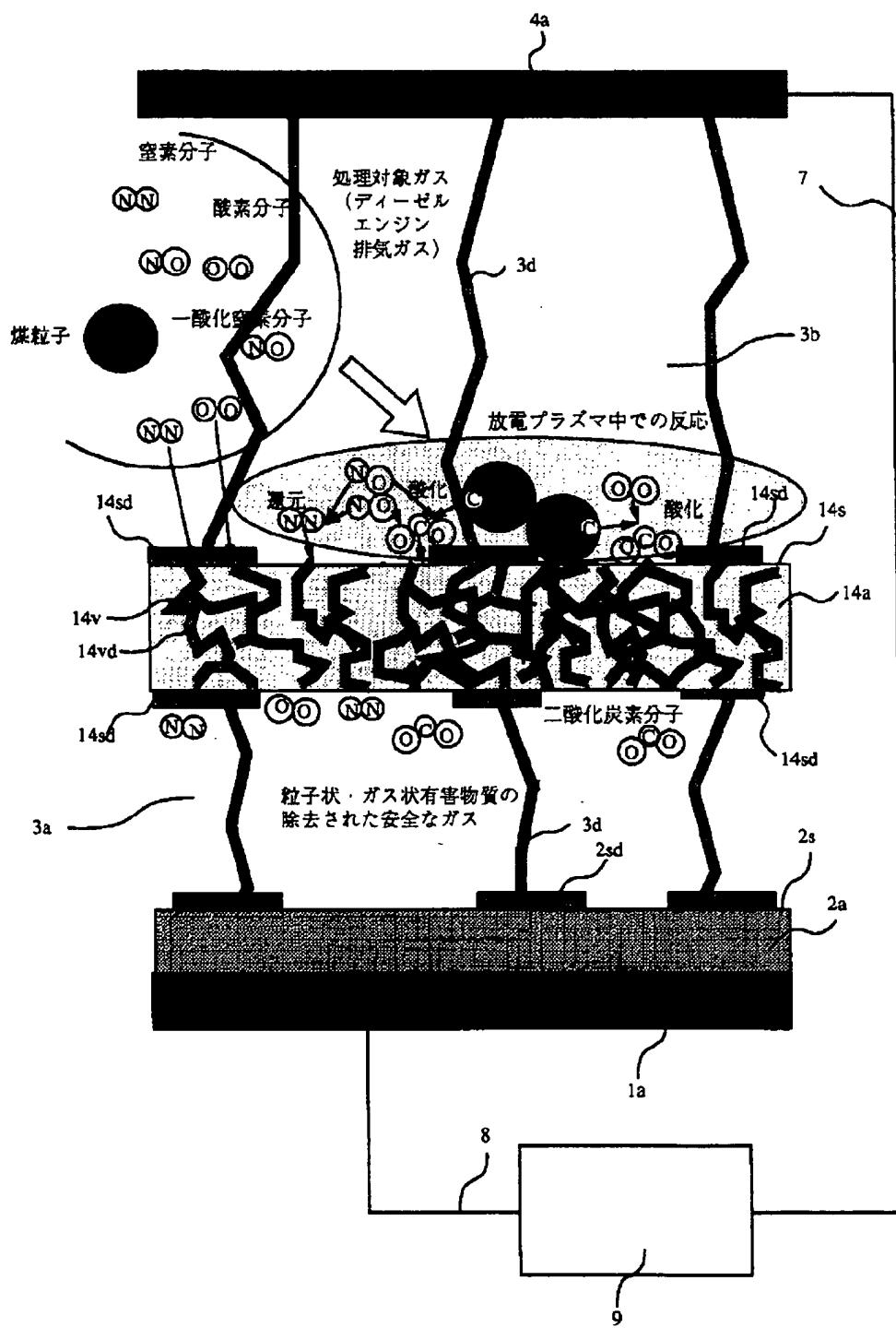
【図3】



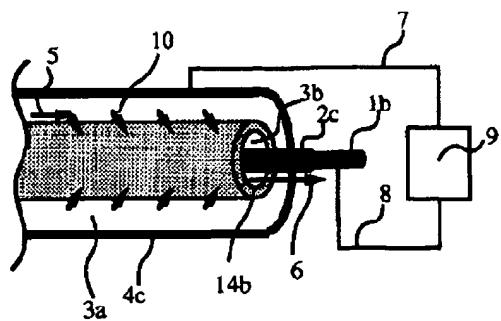
【図4】



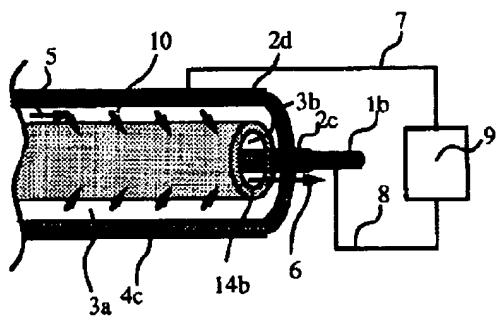
【図2】



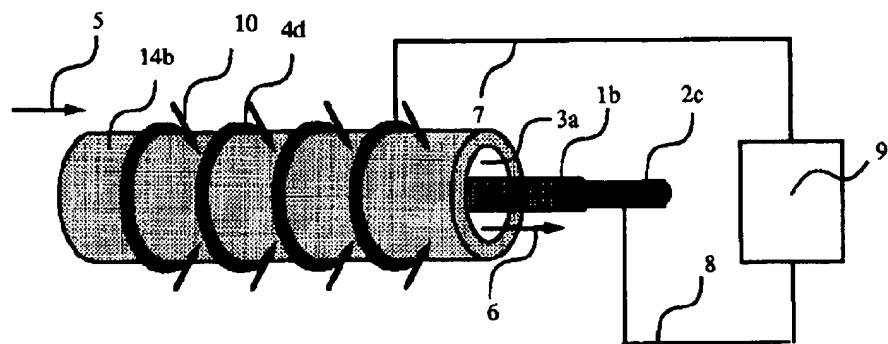
【図5】



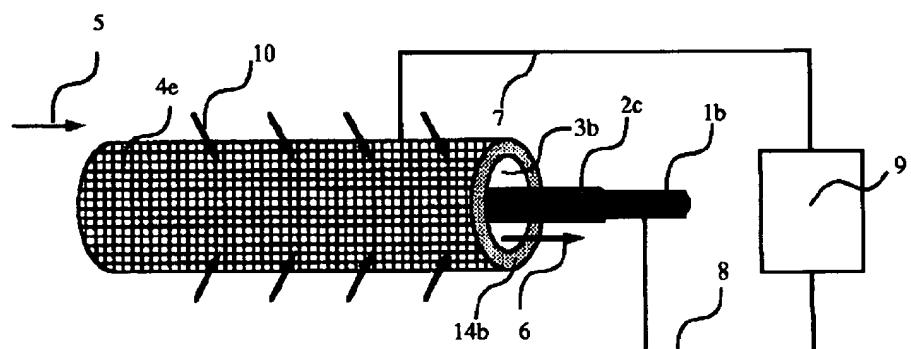
【図6】



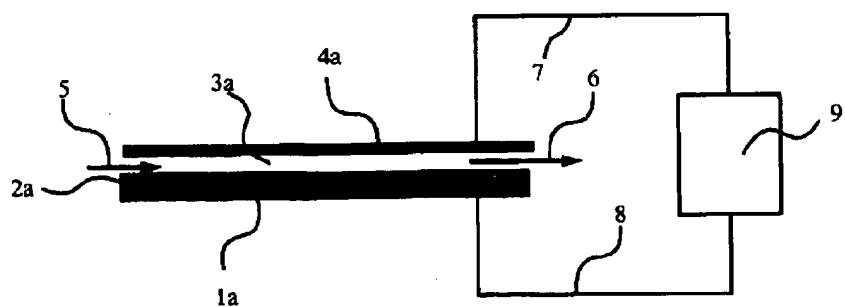
【図7】



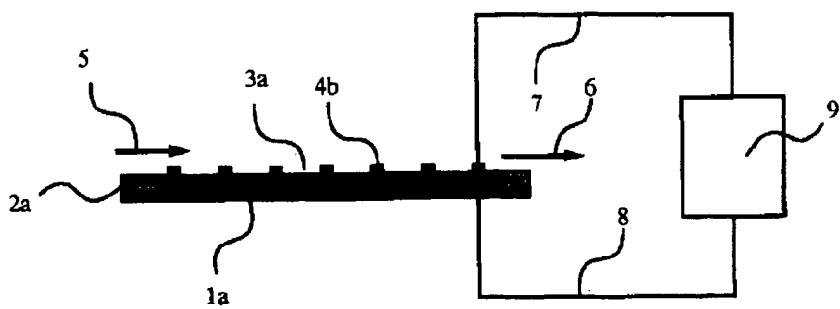
【図8】



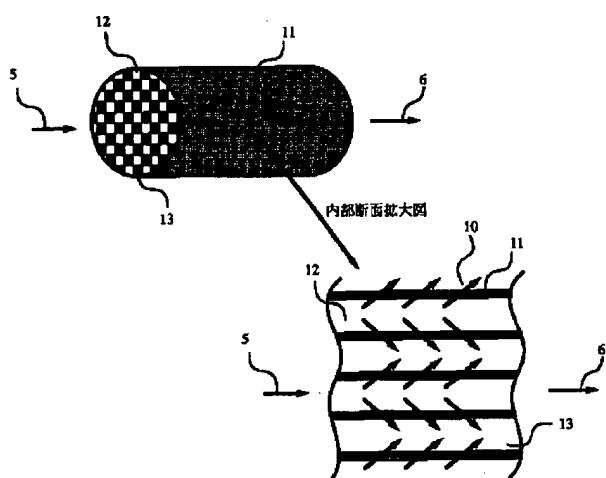
【図9】



【図10】



【図11】



フロントページの続き

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